

First in Fleet: KC-135 Global Air Traffic Management (GATM)

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The advent of global air traffic management (GATM) is radically changing the world of global reach aviation. To ensure the United States military access to global air routes, all aircraft using them must reach these standards by the time the world's air traffic control systems are converted to meet the GATM requirements. The complex modifications to aircraft and operations are made more difficult by the amorphous and changing requirements of the overall GATM system. The Global Reach System Program Office put together a program to meet the GATM needs of the KC-135 tanker aircraft being flown by the Air Mobility Command. The KC-135 GATM program has the privilege of being the first Department of Defense (DoD) GATM program to deploy a full-up GATM capability.

The KC-135 Program

The success of the KC-135 GATM program can be traced directly back to the building block nature of the program and lessons learned from earlier KC-135 programs. The Air Force did not want the first GATM aircraft fleet to end up a boat anchor. Actually, the KC-135 was not originally intended to be the Air Force's first GATM program. The C-5 Aviation Modernization Program (AMP) went on contract before the KC-135, and the KC-10 and C-17 were scheduled to deliver aircraft with GATM ahead of the KC-135. The KC-135 GATM program pulled ahead and passed all of these programs because it met key Air Force needs: a program that could lead the fleet and supply a first capability to support the deployed air forces with tankers and cargo carriers, and that could pave the way for the GATM modifications in other Air Force aircraft.

Lessons learned from past KC-135 programs among others indicated the need to address three key program areas: a strong systems engineering development approach, a solid system safety engineering process, and a robust test program. The KC-135 GATM program focused on these areas to improve and capitalize on the lessons learned. The Wright-Patterson program was set up to ensure a developmental approach to the integration of mainly commercial-off-the-shelf (COTS) equipment. Both the contractor and the government strove to develop a MIL-STD-882 safety program that would guarantee the

completed product would be airworthy and meet user needs without major changes. Developmental and operational testers were brought early into the program to make certain a sufficient level of test and evaluation was used to wring out the design and the final aircraft.

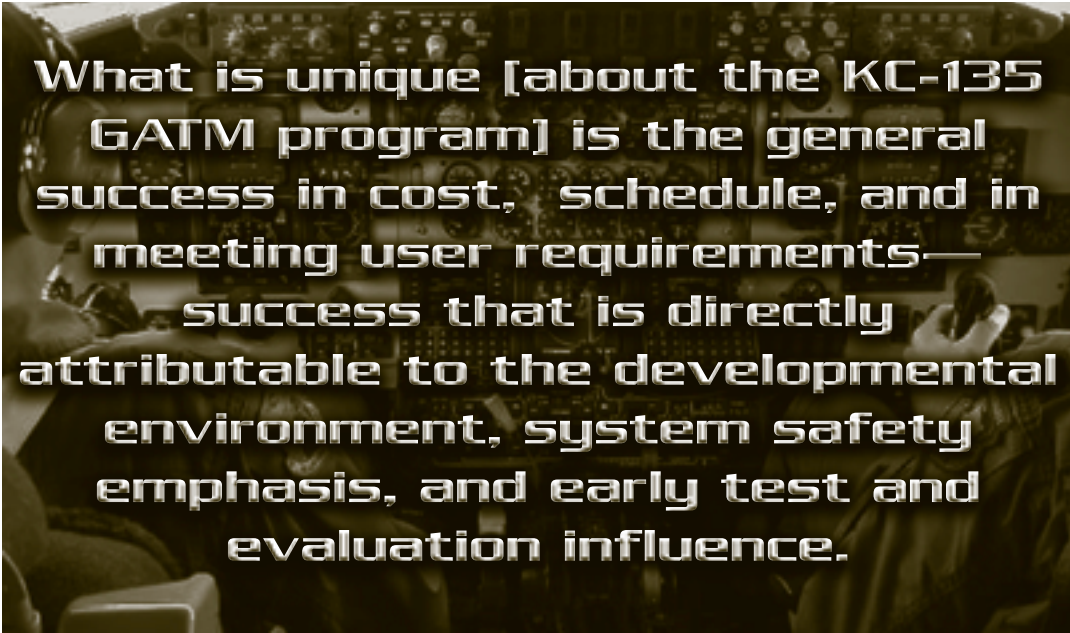
These steps were very successful and produced a product on time with little cost growth. The details of the organization of these three critical pieces of the KC-135 GATM program will benefit the design of any government acquisition program, especially for COTS-based or largely COTS-based acquisitions that require military agency certification.

Systems Engineering Development Approach

Major modifications to complex systems are not exclusively sustainment activities. They necessitate the involvement of developmental system experts and expert integrators. In the Air Force, the Aeronautical Systems Center is the primary developer for aviation systems. The use of this organization's deep engineering experience and tight relationship with the Air Force Research Lab was fundamental in aiding the success of the KC-135 GATM program. Additionally, the Electronic Systems Center provided support to the program in avionics and data systems. This support included a GATM performance assessment and a data chain certification of the Air Force Flight Management System (AFFMS) and the digital aeronautical flight information file (DAFIF) it uses. This focus on a data chain certification to assess the navigation database subsystem is unique in the military but reflects an obvious need to ensure the safety and airworthiness of these types of highly integrated navigation systems. This is a parallel effort with civil systems such as the Jeppesen navigation database, but it takes a step ahead under the aegis of Air Force airworthiness that is necessary for military systems. The eventual goal for the Air Force is to achieve a fully airworthy navigation database.

The integration of COTS items is a developmental effort. This focus in the program was a key factor leading to its success. Every effort was made in the KC-135 GATM program to acquire previously certified and civil-certified

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components. This saves money by significantly reducing the cost to test, verify, and certify individual components. This way, the focus of the program was fully on making the pieces work together and certifying the integrated system. A program that doesn't ensure this requires deep investments in engineering, test, and safety to develop and certify the components as well as the overall integration.

COTS itself can become both a cost and sustainment driver in the support of a program. No program can completely isolate itself from these certain problems, but the KC-135 GATM program did work to reduce these problems by using state-of-the-art and certified equipment.

The key to a successful low-cost program of this type is the basic focus on engineering development.

Emphasis on System Safety Engineering

The key to ensuring airworthiness and successful integration of anything in a complex system is system safety engineering, the function that joins together the disparate engineering functions and test and evaluation and that ensures the overall safety of the components, integration, and design. Although other functions handle pieces of system safety, only system safety engineering brings together these areas and sculpts the overall airworthiness and safety of the complete system. It is key to note that some of the greatest disasters related to the lack of appropriate system safety are not just the missing function, but rather, the fact that full integration of system safety at any point in the program would likely have prevented the mishap as well as reduced the program costs and overruns.

With this in mind, the KC-135 GATM program incorporated, and the contractor supported, a very strong sys-

tem safety process. This was a reaction to past KC-135 programs and to several mishaps in other systems that were directly attributed to a failure to incorporate system safety.

The system safety program from government to contractor was characterized by good communications and strong and appropriate government insight and oversight. Specifically, the deliverable docu-

ments to the government system safety process and the approval of those documents were the key to communication, contractor and government understanding of the safety of the system, and risk acceptance by the U.S. government. In an era when programs seek to reduce deliverables as much as possible, these reports and analyses are obviously core to successfully producing a system the government can certify. Additionally, in the KC-135 GATM program, these documents ensured that the program met costs and schedule. Without these deliverables, the program would not have been able to certify the system airworthy in a timely or cost-effective manner.

Importance of Test and Evaluation

The KC-135 GATM program was unusual in its dedication to early test planning and integration. Additionally, the strong system safety function pushed the program to ensure a good verification strategy as a part of the system safety process. Although all training and guidance on acquisition recommends early test involvement, an unfortunate characteristic of many acquisition programs is the lack of adequate test planning until the end portion of the program. This results in poor verification, lack of timely deficiency identification, and other serious problems in the system that cause cost and schedule growth or, even worse, safety mishaps. Another critical issue is the Air Force's policy not to make operators unintentional developmental test pilots. The danger of this is obvious and the potential lack of user trust if an improperly or untested system harms the operator or leads to a military failure is a significant national policy issue.

Unlike many programs that don't bring in testers early, the KC-135 GATM program fully integrated both developmental and operational testers and test into the program. Test and evaluation found many deficiencies and verified the overall capabilities of the system. The key

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input to the program was the verification of the safety and airworthiness of the system, but the discovery of deficiencies prior to operational test or operational use is a necessary method of ensuring the user does not get an unsafe or unusable system.

The dedication of the KC-135 GATM program to test and evaluation resulted in a capable system that has already easily passed operational test and evaluation. The program influenced the integration of operational and developmental test, and inspired the program team to implement a new acquisition best practice. Usually modern programs use combined test and evaluation to save test costs and to improve the test collaboration between operational and developmental test and evaluation. The KC-135 GATM program took test and evaluation to the next level by integrating the developmental tests and operational tests to improve the system prior to dedicated operational test. This collaboration ensured the program met the operational requirements and succeeded in dedicated operational test.

A Model for Success

The KC-135 GATM program is not a singular or unique program. It is representative of the types of programs that the DoD is working on now and those that it will fund in the future. What is unique is the general success in cost, schedule, and meeting user requirements—success that is directly attributable to the developmental environment, system safety emphasis, and early test and evaluation influence. Modern complex integration programs in the DoD that involve system of systems controlled by public agencies will succeed if they follow the model of the KC-135 GATM program.

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